

NORTH POLAR OCEANOGRAPHY.¹

A HANDSOME volume full of useful information has been given to oceanographical science by H.R.H. the Duke of Orleans, the result of a cruise in the Greenland Sea during the year 1905. This is one of a series of Arctic cruises His Highness has been making for a number of years, the last having been during the summer of 1909. On each of these voyages the Duke of Orleans has carried with him an excellent scientific staff on board his yacht, the *Belgica*, a vessel already known in Antarctic exploration. Among those who have been with him are Dr. Récamiér, who has accompanied the Duke on each of his previous voyages, as well as Captain Adrien de Gerlache, formerly leader of the Belgian Antarctic expedition, M. E. Mérite, the artist-naturalist, and Mr. E. Koefoed.

to west over to the Greenland coast in as high a latitude as $75^{\circ} 30' N.$, a region which has been inaccessible to other expeditions trying it. Along this route a complete set of soundings and serial temperature and salinity observations were made. The coast of Greenland was met on July 27, and the Duke landed on an island, rich with Arctic vegetation, just south of Cape Bismarck, and which he named "Ile Marous-sia." At 8 a.m. on July 28 the *Belgica* was four miles north of Koldewey and Payer's cairn, the furthest north point of the German expedition of 1870. At noon the *Belgica's* position was $77^{\circ} 20' N.$, $18^{\circ} 20' E.$, and in the evening a party landed on a previously unknown island, which was named Ile de France, the south-east cape of which, in $78^{\circ} 38' N.$, $17^{\circ} 36' W.$, was named Cape Philippe. Here the French colours were hoisted. Koefoed found nineteen phanerogams, seven mosses, four fungi, and six lichens; hares,



FIG. 1.—The *Belgica* in land ice on August 4, 1905 (Lat. $77^{\circ} 29' N.$, Long. $18^{\circ} 31' W.$).

The volume opens with a narrative of the voyage and an extract of the ship's journal, by Captain de Gerlache. The *Belgica* left Tromsø on June 3, and, passing northward to the west of Spitsbergen, sighted Prince Charles Foreland in exceptionally clear weather, reaching $80^{\circ} 20' N.$ in this longitude. From this point the Duke attempted to push westward towards Greenland, not to establish "un vain record," but to carry on serious scientific investigations in an unexplored region of the Arctic Ocean. This attempt was repulsed by heavy ice, which drives southward from the polar basin between Spitsbergen and Greenland. The special object was to verify the hypothesis that a ridge separated the Greenland Sea from the North Polar basin, but though unsuccessful in this attempt, the expedition succeeded in crossing from east

ptarmigan, foxes, and lemmings abounded. The remains of Eskimo encampments were also found.

At midnight on July 30 the *Belgica* was in $78^{\circ} 16' N.$, $16^{\circ} 48' W.$, or 167 miles further north than the *Germania* in 1869. From this point the *Belgica* pushed eastward, and thirty miles eastward, after getting shallowing soundings of 245, 120, and 55 fathoms, struck bottom at 32 fathoms, and named this bank the Belgica Bank. Six miles to the south-east of this point the water deepened again to 109 fathoms. de Gerlache suggests that there may be an island in the vicinity, noting that two crows and a walrus were seen. After this the Duke returned by more or less the same route so far as Cape Bismarck, and from there in a more or less southerly direction in, and along, the edge of the Greenland pack, which they lost sight of on August 21 in about $67^{\circ} 30' N.$, $24^{\circ} E.$ It is satisfactory to note that at almost the furthest north point reached a well determined position

¹ Duc d'Orléans. "Croisière Oceanographique accomplie a bord de la *Belgica* dans la Mer du Grönland, 1905." Pp. v+568; lxxix plates. (Brussels: Bulens, 1907.) Price 100 francs.

was obtained, viz. $78^{\circ} 13' N.$, $16^{\circ} 30' W.$, and that the coast was mapped approximately to $79^{\circ} N.$ All that is mapped is satisfactorily determined except Cape Bourbon and Cape Bergendal, the distances of which were judged, only single angles being taken. A good declination was obtained in $77^{\circ} 35' N.$, the result being $37^{\circ} N.W.$

Full extracts of the journal compiled on board are published. Here we are given the time and position, the weather, the sea, ice observations, stations, and movements of the

south. Plate Ix. shows deposits from the north of Scotland to north of $80^{\circ} N.$ All is blue mud, except the globigerina ooze, which pushes north-east from west of Scotland to within 240 miles of Bear Island, broken only by the volcanic muds of Iceland and the Færøes.

Dr. C. H. Ostenfeld treats the botany in a systematic manner, but beyond the further northern extension of known East Greenland species there is naturally nothing very novel.

Mr. Einar Koefoed and Captain de Gerlache give

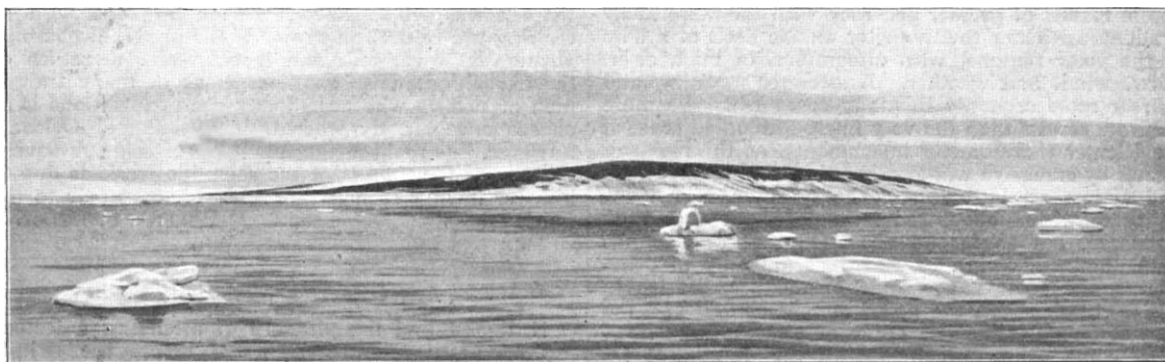


FIG. 2.—Cape Philippe.

ship, and the animals met with, in a thoroughly systematic manner. Next come a list of eighty soundings and fifty oceanographical stations, showing good solid work. The soundings vary from 12 to 1846 fathoms. Many hydrographic observations were taken, and plankton and other fishing was carried on.

Meteorology has been well handled by Dr. Dan la Cour, the observations of twenty-two ships having been considered, as well as thirty-eight land stations, though one misses the observations taken by Scottish whalers in the Greenland Sea and Davis Straits.

an account of oceanographical equipment which, with the exception of the excellent Lucas sounding machine, was mostly Danish or Norwegian. There follows a useful journal of the fifty stations, mostly in the Greenland and Spitsbergen seas. This journal gives a summary of the hydrographic and other work done at each station, and lists of planktonic species. Messrs. B. Helland-Hansen and E. Koefoed then proceed to discuss the hydrography of the expedition, and no expense is spared in enhancing this part of the report with a very excellent series of useful, interesting, and



FIG. 3.—Duke of Orleans Land, near Cape Amelia

There are ninety-six synoptic charts for July and August, 1905, which are of great interest.

Mr. O. B. Boggild reports on the geology. He has a theory of a submarine moraine existing to the east of Greenland, running parallel with the coast, but this is scarcely supported by the bathymetrical chart (plate Ivi.). The geological observations at Cape Saint Jacques ($77^{\circ} 36' N.$), on the Ile de France, are of most interest. Here there are gneisses and schists, and possibly some Devonian rocks probably identical with those that Nathorst found further

beautiful plates and maps for the purpose of demonstrating the distribution of depths, temperature, salinity, currents, &c. Most of the introduction is a summary of the hydrographic work of previous expeditions to the Greenland seas, but Messrs. Koefoed and Helland-Hansen have made no mention of Mr. Leigh Smith's work of 1870, nor of that done on board the *Princesse Alice* during 1898 and 1899, mostly by Mr. J. Y. Buchanan and the reviewer. Leigh Smith was the first to notice the intermediate warm layer in these seas which is specially dealt with by

Messrs. Koefoed and Helland-Hansen, yet no mention of this veteran's name or work is made. Buchanan, Nansen, Bruce, and others have also observed this phenomenon. We doubt also if some of these old observations are less exact than those of more recent date. The Buchanan methods give, for instance, observations of great exactitude, and certainly equal to any of the most recent observations of the younger Scandinavian school of oceanographers.

Part ii. deals with instruments and methods; and here useful discussion could be entered upon, as, for instance, on the question as to whether one is able to obtain results of greater accuracy with the more finely graduated Richter thermometer on the deck of a ship in the polar regions, with discomforts of mist, sleet, snow, wind, and weather. A stronger marking and coarser scale certainly in many cases will give more accurate results than the very finely-graduated scale of the Richter thermometer instruments, as the reviewer knows by extensive work on board ship in all weathers and almost all latitudes. The question of a ridge rising to within about 400 fathoms of the surface is discussed, but so far no absolute proof of this has been obtained, owing to the great difficulty of penetrating the polar pack—some of the heaviest ice in the world—between the north of Spitsbergen and the east of Greenland. The Duke of Orleans has, however, come nearer accomplishing this important investigation than anyone else, for he obtained a more complete line of soundings two degrees further north in the middle longitudes of the Greenland Sea than any previous navigator.

The authors divide the Greenland Sea into three areas:—

- (1) East—having high temperatures and salinities, being influenced by the Gulf Stream.
- (2) Middle—a deeper region with mixed conditions.
- (3) West—a shallower region with low temperatures and salinities, being influenced by the polar current.

Plate lxii. gives a chart indicating the stations of the *Belgica* and those of other expeditions in the Greenland seas and regions adjacent; but again we miss the stations of Leigh Smith, 1870, those of Bruce (S.Y. *Blencathra* of Major Andrew Coats), 1898, and those of the Prince of Monaco, 1898-9. Many interesting problems are raised by the temperature, salinity, and current observations made by the Duke of Orleans and his staff, and not least of them is the theory of the Spitsbergen-Greenland ridge already referred to, but it is impossible in this short review to enter fully into all these questions.

The zoology of the voyage, discussed by Prof. C. Hartlaub, Messrs. D. Damas, E. Koefoed, and M. J. G. Grieg, occupies more than a third of the volume. The plankton work is very exhaustively and thoroughly handled by Messrs. Damas and Koefoed. Several dredgings in depths down to 750 fathoms also secured a number of interesting benthic forms. The numerous inset maps and sectional diagrams and tables are especially useful, bearing as they do on the distribution of plankton.

The plates by Werner and Winter maintain the high reputation this firm has justly won. M. Édouard Mérieux's work is reflected throughout the natural history of the expedition, though much of this excellent artist's colour work only appears in the Duke of Orleans's less technical work, "A Travers la Banquise du Spitzberg au Cap Philippe." Dr. Récamier, too, did much to make the voyage a success. There are useful sketches of the new coast between 77° and 79° N., and some most excellent half-tone blocks, many of which show polar ice well; the frontispiece is especially to be commended as "a thing of beauty." One regrets to see that glazed paper is used

instead of pure rag paper, which actually produces richer effects and is infinitely more durable.

Altogether the Duke of Orleans is to be most heartily congratulated, not only for having personally conducted all the above work, but even more so for having placed the observations and material gathered during the voyage into competent hands for examination and description, and for having spared no trouble or expense in bringing out a volume which is second to none as a monumental contribution to the oceanography of the Arctic Ocean. Too often polar expeditions are dispatched by the help of men of means, but these same people have little or no conception of making use to the full extent of the material, obtained with great care, toil, and trouble, on the return of the expedition. The excellent work of many trained men of science who accompany such expeditions is in consequence largely wasted. The Duke of Orleans, however, has realised the full value of this subsequent work, and the thanks of the scientific world is due to him for having seen it through so handsomely to the finish.

WILLIAM S. BRUCE.

AÉROPLANE STABILITY.

IN 1896 I had the pleasure of attending a lecture on naval architecture given before the British Association in Liverpool by the late Dr. Francis Elgar, F.R.S. I had learnt the theory of the metacentre in my undergraduate days, but it came to me as a great surprise to learn that this theory had only been evolved after many ships had foundered, owing to want of theoretical knowledge of their conditions of stability.

I was interested in aerial navigation at the time, and although I had not got further than throwing gliders, it was evident from their behaviour that a mathematical theory of stability must necessarily be of even greater importance in connection with aerial navigation than with naval architecture, and I wrote in *Science Progress* to the effect that if the future development of artificial flight were not to be a repetition of the chapter of accidents by which naval architects had gained their theoretical knowledge, there would be abundant work for mathematicians in reducing the conditions of stability to pure calculation.

About the year 1903 I noticed that if a glider or other body is moving in a resisting medium, such as air, in a vertical plane with respect to which it is symmetrical, the small oscillations about steady motion in that plane are determined by a biquadratic equation; and Prof. Love directed my attention to the condition of stability given by Routh. Mr. W. E. Williams was a post-graduate student in my department, and with his collaboration we published a paper on "The Longitudinal Stability of Aerial Gliders" (Proc. Royal Soc., lxxiii.), which was intended to direct attention to the general method, and the importance of further investigation, rather than to furnish a complete solution of the problem.

Mr. Williams shortly afterwards obtained a so-called "Research Fellowship"; but "research" in this case was interpreted as meaning practical work done in a physical laboratory away from Bangor, so the award had the effect of preventing the continuation of original work on this important problem. On the other hand, the necessity of providing, with one assistant, classes in all grades of pure and applied mathematics, and of devoting special attention to the requirements of junior students whose knowledge of the "first four books" and of arithmetic had been neglected at school, left no time for me to carry on the work single-handed. It is only since the comparatively recent abolition of these *infra* university